

UNIDIRECTIONAL FLOW CONTROL SEALING MATT

The present invention generally relates to a filtration apparatus and more specifically relates to a multi-well filtration or solid phase extraction apparatus.

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Multi-well filtration and/solid phase extraction assemblies are well known in the art and are used for the processing of biological liquid specimens for subsequent assay. Conventional assemblies typically comprise a filtration plate, or an extraction plate, having multiple wells for receiving a liquid specimen, and a collection tray
10 having a plurality of wells for collecting filtrate. The filtration/extraction plate and the collection tray are disposed in a stacked relationship such that individual collection wells are associated each with a single filtration/extraction well. A conventional multi-well filtration plate has 96 wells for processing multiple samples simultaneously. Each well typically contains a separating media, for example a filter
15 member, for partitioning a biological component from the liquid that is introduced into the filtration plate, and allowing a liquid portion of the biological fluid to flow into the collection tray.

Leakage or premature flow through the filtration/extraction plate is
20 undesirable. Heretofore, there has been no available apparatus or method for positively preventing fluid flow through a filtration/extraction plate prior completion of any reaction. The present invention provides for a unidirection flow control sealing matt for use with both the filtration and extraction plate apparatus.

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Summary of the Invention

A well plate seal in accordance with present invention generally includes a matt heading a plurality spaced apart wells for engaging and sealing a plurality of exit
 5 ports in a multi-well filtration/extraction plate. A unidirectional flow control valve is disposed in each of the plurality of matt wells for enabling liquid flow out of each exit port only upon application of a pressure differential across each exit port. More particularly the matt is preferably flexible for facilitating a removable engagement with the filtration/extraction plate exit ports and the matt and plurality of valves are
 10 also preferably integrally molded with the matt.

Each of the plurality of valves may comprise a duck-bill valve and the matt may be suitable for use with filtration/extraction plates having 96 wells.

15 In order to facilitate placement of the well plate seal onto a filtration/extraction plate and seal each of the exit ports each matt well includes a tapered side wall.

Brief Description of the Drawings

20 The present invention will be more clearly understood and the objects and advantages better appreciated by referring to the following detailed description considered in conjunction with the accompanying drawings of which:

Figure 1 shows an exploded perspective view of prior art multi-well filtration
 25 apparatus for which the present invention is directed;

Figure 2 shows an exploded view of the multi-well filtration apparatus shown in Figure 1 with the unidirectional flow control sealing matt in accordance with the present invention;

Figure 3 shows a cross-sectional view of the apparatus showing the sealing
 30 matt in place for controlling flow through the multi-well extraction plate;

Figure 4 is an enlarged perspective view of a duck-bill valve which provides unidirectional flow control; and

Figure 5 is a cross-sectional view of the valve shown in Figure 4.

Detailed Description

Turning now to Figure 1, prior art multi-well filtration apparatus 10 for use
 5 with the present invention is shown. This apparatus 10 is shown in copending U.S.
 patent application SN 09/767,500 filed January 23, 2001 entitled MULTI-WELL
 FILTRATION APPARATUS and is to be incorporated into the present application by
 this reference thereto. The apparatus 10 is described hereinafter in order to clearly
 explain the use of the present invention.

10 The apparatus 10 generally includes a filtration/extraction plate 12 adapted to
 receive a fluid, for example a blood specimen or other biological fluid, a vacuum
 collar 14, and collection means 16 for capturing and containing components of the
 biological fluid passed through the filtration/extraction plate 12. Means, for example
 15 a hose barb connector 18, for connecting the vacuum collar 14 to a vacuum source
 (not shown) is also included.

The filtration/extraction plate 12 may comprise a conventional, multi-well
 filtration/extraction plate. The filtration/extraction plate 12 includes means, including
 20 a plurality of wells 22, for example 96 wells, for receiving multiple test samples of a
 biological fluid to be processed by filtration or solid phase filtration/extraction
 techniques. The filtration/extraction plate wells 22 will hereinafter sometimes be
 referred to as "filtration wells". It will be appreciated that the number of wells 22
 found in the extraction plate 12 in the embodiment 10 shown is simply a matter of
 25 convenience for the analyst or investigator. The filtration/extraction plate 12 may
 contain as few as one well, or as many wells as are functionally permissible to give the
 actual dimensions of the plate 12 (e.g. 384 or 1526 wells). Typical test samples of a
 biological fluid are often less than about 100 microliters in volume, and the wells 22
 are sized appropriately to contain these small volumes. The filtration/extraction plate
 30 12 may be formed of any resilient and non-reactive material that is commonly
 available.

A filtration/extraction media 24 may be disposed generally at a bottom of each of the filtration wells 22 and functions to separate and retain components of the biological fluid as the fluid passes through the well 22. The filtration/extraction media 24 comprises any filter, membrane, matrix or the like, in a single layer or multiple
 5 layers thereof, that is suitable for the application on hand.

The filtration/extraction plate 12 may be a substantially unitary, molded structure with each of the filtration wells 22 comprising a generally cylindrical or frusta conical aperture 34 extending through a full thickness, or depth, of the
 10 filtration/extraction plate 12. More specifically, each filtration well 22 includes a relatively wide receiving inlet portion 38 and relatively smaller exit port 42 forming a nozzle-like tip. The filtration/extraction media 24 is disposed at the bottom of the inlet portion 38 as shown, and may be held in place by friction, a retaining ring, or other conventional means (not shown). The filtration/extraction plate 12 includes a
 15 substantially rectangular upper portion 44 having a face 46 in which the filtration wells 22 form a matrix arrangement as shown and a lower portion 48 from which the exit ports 42 of the filtration wells 22 depend.

The collection means 16 comprises a multi-well collection plate 54. The
 20 collection plate 50 includes means, for example a plurality of wells 52, for receiving a liquid component, i.e. filtrate or eluate, of the biological fluid sample which is discharged from exit ports 42 of the filtration wells 22. The collection plate 50 may include any number of such wells 52, with a 96-well collection plate being a typical example.

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A vacuum collar 14 may be adapted to interface and interconnect the filtration/extraction plate 12 and the collection plate 16. More specifically, the vacuum collar 14 includes inner wall 62 defining a generally central space 64, and an outer wall 66. Space 64 is sized to receive the lower portion 48 of the
 30 filtration/extraction plate 12 and the face 54 of the collection plate 16.

When the vacuum collar 14 is interconnected between the filtration/extraction plate 12 and the collection plate 16, each one of the collection wells 52 is aligned with

an associated one of the filtration wells 22. In the shown embodiment, the vacuum collar 14 is adapted to position the outlet tips 42 of the filtration wells 22 a specified distance into the collection wells 52, thereby insuring that filtrates or eluates will not contaminate adjoining wells.

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In addition to the hose barb fitting 18, the vacuum collar 14 may include a valve 70 in communication with the chamber 64. The valve 70 may be used to facilitate venting of the system as needed, through port 72, and may be opened and closed by means of handle 16.

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It should be easily appreciated from the description of the filtration/extraction apparatus described and shown in Figure 1 that there is no positive means for preventing fluid passage through the exit ports 42 of fluid deposited in the wells 22. Thus, there is an opportunity for premature leakage or passage of fluids through the exit ports 42 which may cause incomplete reactions of specimens disposed in the individual wells 22.

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With reference to Figure 2 there is shown a well plate seal 100 in accordance with the present invention which solves this problem. Also shown Figure 2 and in combination therewith is the apparatus 10 with character references therein identifying identical or substantially similar elements as hereinabove discussed in connection with the prior art shown in Figure 1.

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The well plate seal 100 includes a sealing mat 102 having a plurality of spaced apart wells 104 for engaging in sealing a plurality of the exit ports 42 of the multi-well filtration/extraction plate 12.

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Unidirectional flow control valves preferably duck-billed valves, 110, more clearly shown in Figures 3-5, are disposed in each of the plurality of matt wells 104 for enabling liquid flow out of each of the exit ports 42 only upon application of a pressure differential across each exit port 42 which is selectively established by the apparatus 10 hereinabove described.

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The well plate seal 100 may be formed in any suitable material, such as silicon or the like and is preferably flexible for facilitating removable engagement with the extraction plate exit port 42. The mat 102 may be disposable or reusable with proper decontamination procedures as desired.

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As shown the mat 102 and plurality of valves 110 are integrally molded to facilitate mass production thereof. The mats 102 may be molded with perforations (not shown) between rows and/or columns of the valves 110 to enable adaption of the mat 102 for a various sized extraction plates (not shown) with a different numbers of exit ports.

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With reference to Figures 3-5 the plurality of valves 110 each include a duck-billed valve 116 which enables unidirectional flow, as indicated by the arrow 118 in Figure 5, upon application of a pressure differential across each exit port 110 as provided by the apparatus 10 hereinabove described. The duck-billed valve 116 and mat 102 are preferable integrally molded in order to facilitate manufacture thereof as hereinabove noted.

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As most clearly shown in Figure 5 each matt well 104 includes tapered side walls 120 for facilitating placement of the well plate seal 100 including the mat 102 on each of the exit ports 42. The tapered side walls 120 enable the guiding and justification of the mat 102 with the plurality of exit ports 42 to achieve an assembly as shown in Figure 3.

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A method in accordance with the present invention for providing flow control to exit port 42 of the multi-welled filtration/extraction plate 12 includes the steps of installing on to the multi wellled filtration/extraction plate 12 a matt 102 having a plurality of spaced apart wells 104 with each well 104 sealing a corresponding exit port 42. Each well 104 includes a unidirectional flow valve 116 for enabling liquid flow out of each exit port 42 only upon application of a pressure differential across each exit port 42. The method further includes applying a pressure differential across each exit port 42 utilizing the apparatus 10.

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More particularly with the method in accordance with the present invention provides for providing a tapered side wall 10 on each matt well 104 for facilitating placement of the matt 102 onto the multi-well extraction plate 12.

- 5 More specifically this step of installing matt 102 onto the multi-well filtration/extraction plate 12 includes installing the matt 102 with the flow valves 110 comprising duck-billed valves 116.

- 10 Although there has been hereinabove described a particular arrangement and method of a well plate seal in accordance with the present invention for the purpose of illustrating the matter in which the invention may be used with vantage, it should be appreciated that the invention is not limited thereto. Accordingly, any and all modification which may occur to those skilled in the arts should be considered to be within the scope of the present invention as defined in the appended claims.

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